National Aeronautics and Space Administration

A World of Change

NASA SUMMER OF INNOVATION

UNIT
Earth and Space Science - Remote sensing
GRADE LEVELS
7th -9th

CONNECTION TO CURRICULUM
Science, technology, mathematics and geography

TEACHER PREPARATION TIME
1 hour
LESSON TIME NEEDED
4.0 hours *Complexity: Basic to Moderate*

LESSON DESCRIPTION
These activities will introduce students to Earth's remote sensing tools and changes observed from space over time.

OBJECTIVES
Student will:
• Simulate how light collected from a space object converts into binary data and reconverts into an image of the object.
• Experience the practical value of remote sensing at an introductory level
• Interpret, assess, and predict changes in the nature and spatial extent of land use at the landscape (regional) scale, using land remote sensing images
• Analyze the extent of urban development and the impacts on natural resources as land cover changes
• Perceive a regional (landscape scale) context for local change
• Develop skills of visual analysis of remote sensing images

NATIONAL STANDARDS

National Science Education Standards (NSTA)
- Science as Inquiry and the Abilities required to do Scientific Inquiry
- Evidence, models, & explanation
- Change, constancy, & measurement
- Earth in the solar system
- Processes that Shape the Earth
- The Nature of Technology and Science
- Abilities of technological design
- Understanding about Science & Technology

Principles and Standards for School Mathematics (NCTM)
- Number & operation
- Patterns, function, & algebra
- Measurement
- Data analysis, statistics, & probability
- Communication
- Connections
- Representations

National Geography Standards (NCGE)
- The World in Spatial Terms

National Technology Standards (ISTE)
- Understand cultural, social, economic, &political effects of technology
- Ability to use & maintain technological products & systems
- Understand, select, & use:
    - Medical technologies
    - Agricultural technologies & biotechnologies
    - Energy & power technologies
    - Information & communication technologies
    - Transportation technologies

- Manufacturing technologies
- Construction technologies

MANAGEMENT
Each activity within this unit has materials that will need to be downloaded and printed in advance of the lessons. While the Paint By Numbers activity can be duplicated in Black and White, the majority of the Landsat images will need to be reproduced in color. The transparency grids for each activity may be reproduced through the use of appropriate ink jet or laser printer transparency film.

Since working with satellite material is new to many instructors it would be recommended to review the Getting to Know Your Satellite Imagery activity referenced at the end of this lesson plan. This activity may be used as a separate student activity as well.

Students should work in pairs in scrutinizing their images as we see and interpret images differently. This is one of the underlying objectives for Paint By Numbers. This is also helpful with materials management.

CONTENT RESEARCH
Many people do not differentiate between data received by satellites and the "pictures" we see as a result.
Some concepts to reinforce might be:

•**data** is made up of **pixels** that represent data received by a particular sensor.
•Individual pixels represent generally larger areas than most people understand in looking at remote imagery. ie, Landsat pixels are 30 meters by 30 meters. A separate special activity might help students to understand how large a space this is.
•high **resolution** is not always required for the mission's tasks, but always affects the ability of the scientists or engineers to "zoom in" on the resulting images. Therefore, high resolution is more significant in remote areas where people cannot go to the site for "**Ground Truthing**" of the remote data observations.

LESSON ACTIVITIES
Paint By Numbers
Drawn from the Space-Based Astronomy Activity Guide for Science, Mathematics, and Technology Education. This activity is a paper and pencil introduction to the concept of collecting data from spacecraft as binary numbers and converting these numbers into the image they represent.

Working in student pairs, one student interprets the data of the house image based on the observations of the other student on the team.
In a second phase f the activity, a finer grid pattern is used to make the same comparisons for the planet Saturn.
Paint By Numbers:
http://aesp.psu.edu/files/soi/paint%20by%20the%20numbers.pdf
http://www.nasa.gov/pdf/319891main_Down_to_Earth.pdf p.84

MATERIALS
Paint By Numbers:
- Transparent grid
- Paper grid
- Picture of house
- Pencil

url for original activity to download graphics for duplication and specific procedures.
http://www.nasa.gov/pdf/319891main_Down_to_Earth.pdf

Quantifying Changes in the Land Over Time:

url for specific activity directions:
http://landsat.gsfc.nasa.gov/education/resources/Landsat_QuantifyChanges.pdf

•Phoenix Landsat Movie:
http://landsat.gsfc.nasa.gov/education/resources/Phoenix.mov
•Phoenix Landsat Image 1991: 3,2,1 bands
http://change.gsfc.nasa.gov/data/phoen/classroom/phoen1991-321-q4.tif
•Phoenix landsat Image 2000: 3,2,1 bands
http://change.gsfc.nasa.gov/data/phoen/classroom/phoen2000-321-q4.tif
•Phoenix landsat Images 1991: 7,4,2 bands
http://change.gsfc.nasa.gov/data/phoen/classroom/phoen1991-742-q4.tif
•Phoenix Landsat Images 2000: 7,4,2 bands
http://change.gsfc.nasa.gov/data/phoen/classroom/phoen2000-742-q4.tif
•Transparency Grid:
http://change.gsfc.nasa.gov/data/phoen/classroom/grid.tif
•Grid on white paper 1 per team
•Washable fine point markers
•Any additional images or resources that provide

Quantifying Changes in the Land Over Time
Students learn to identify kinds of land cover (such as roads, fields, urban areas, and lakes) in Landsat satellite images. They decide which land cover types allow the passage of water into the soil (are pervious) and which types do not allow it (are impervious). They consider some effects of increasing impervious surface area on ecosystem health.

Students then make land cover maps using two Landsat satellite images taken about a decade apart. They quantify the change of land cover from pervious to impervious surface during that time period. They make predictive maps of what they think the nature and extent of land cover change in the area will be in the year 2025, and speculate about the consequences for the availability of water for people and ecosystems. Students justify their predictive maps and their thoughts about the consequences of change in writing.

This activity uses Landsat images of Phoenix, Arizona, USA. Additional resources are available to permit teachers to download images of their regions through the USGS Web site provided in the resource section.
Quantifying Changes in the Land Over Time
http://landsat.gsfc.nasa.gov/education/resources/Landsat_QuantifyChanges.pdf

ADDITIONAL RESOURCES
Getting to Know Your Satellite Imagery Introduction Activity:
http://landsat.gsfc.nasa.gov/education/resources/GLOBE_getting2know.pdf
USGS Landsat Gallery of featured Landsat images:
http://landsat.usgs.gov/gallery.php
USGS "Earth Shots" showing environmental image change pairs:
http://earthshots.usgs.gov/tableofcontents

DISCUSSION QUESTIONS
1. How comfortable are you with the accuracy of your data and the conclusions you drew from this information? Why? *Student answers will vary.*
    a. How might you improve the accuracy of your map and your calculations, if at all?
2. Which land cover type changed the most, and which land cover type changed the least? Why do you think this is the case? *There is an increase in human made structures and impermeable surfaces and a decrease in the permeable natural areas.*
3. Researchers indicate that if ten percent of the land cover in a given watershed changes, the water cycling through that watershed changes in significant ways. Water quality is affected, and run-off increases.
    a. How concerned should people be about the cycling of water in the area you have studied with Landsat? *There has been great change over time to impact how water is treated in this region.*
    b. What specific ecological effects of land cover change should be looked into for the geographic area you studied? *Consider air, water, soil, and living things*.
    c. What data would we need to investigate some of those ecological effects? *Answers may vary.*

ASSESSMENT ACTIVITIES
Likert Scale designed with rubrics for evaluating the students' products.
http://landsat.gsfc.nasa.gov/education/resources/Landsat_QuantifyChanges.pdf

ENRICHMENT
Earth+
http://prime.jsc.nasa.gov/earthplus/background.htm
Landsat Change Pair images
http://www.ei.lehigh.edu/learners/luc/landuse_change2.html
NASA's Visible Earth a catalogue of images and animations of our home planet:
http://visibleearth.nasa.gov/
NASA Earth Observatory "World of Change"
http://earthobservatory.nasa.gov/Features/WorldOfChange/